

THE VEGETATION OF THE HEMPSTEAD PLAINS

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WITH PLATE 7

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INTRODUCTION

The Hempstead Plains, in the central part of Nassau County, Long Island, is a bit of prairie similar in aspect to parts of the Great Plains, and appearing quite out of place on the Atlantic seaboard. Its general geographical features were described by the writer a few years ago,* with a very superficial account of the

* Bull. Am. Geog. Soc. 43: 351-360. f. 1-5. May, 1911. Reprinted in abridged form, with a different set of illustrations, in *Torreyana* 12: 277-287. f. 1-7. Dec. 1912. These contain references to some earlier publications which do not need to be cited again here. See also New Internat. Encyc., ed. 2, 11: 133. 1915.

vegetation. The present communication describes the vegetation more fully, but does not attempt a complete enumeration of the flora, which could very well constitute a separate paper of considerable length. Facts previously published will not be repeated here except where necessary for the continuity of the discussion, for the earlier papers are quite accessible.

Although this unique eastern prairie was mentioned in a few early histories and books of travel, and was well known to several local botanists a generation ago as a good place to collect certain species of plants, it was overlooked by all students of vegetation (as distinguished from flora)* until a very late date, when at least three fourths of it had already been obliterated. In a sketch of the fauna and flora of the neighborhood of Cold Spring Harbor by Dr. C. B. Davenport (the flora part contributed by Dr. D. S. Johnson), published in *Science* for Nov. 18, 1898, for the purpose of showing the attractions of that locality for botanists and zoölogists, there is no hint of the existence of a natural prairie, with its many interesting ecological problems, within five miles of the Biological Laboratory (and plainly visible to any one coming out there by train from New York). And for nearly ten years after that none of the botanists or ecologists who attended the summer school at Cold Spring Harbor as instructors or students seem to have known of this prairie, although some of them had lived or studied in Chicago and should have had some acquaintance with prairies.†

In Jelliffe's *Flora of Long Island*, 1899, there is no mention of

* See Torrey *et al.* 1917.

† There is much to be said in extenuation, however, and my own recognition of the unique character of this area was almost as tardy. I had read about the Hempstead Plains in the government soil survey report on western Long Island, by J. A. Bonsteel, in the spring of 1905, and visited Cold Spring Harbor once that year and twice the next, and walked a few times along the western and southern edges of the Plains as mapped in the soil survey report, without noticing anything unusual, until on July 3, 1907, I happened to cross the middle of the area on the way from the Merrick cedar swamp to Hicksville; and the facts were then irresistible. On my previous walks I had passed through only those parts where the original vegetation had been completely destroyed, and the portions visible from the railroad I had probably mistaken for abandoned fields, never having seen a real prairie before. Since 1913 I have obtained much valuable information about this area from Mr. Henry Hicks of Westbury, as did Dr. Bonsteel ten years before, and several subsequent explorers.

the Hempstead Plains, but Hicksville, which is in the heart of the area, is cited as a locality for about twenty species, collected by Dr. G. D. Hulst. (A few of these are introduced, but the majority are typical prairie plants.) The first specific mention of the Plains in botanical literature that has come to the writer's notice is a rather indefinite one in a short paper by William L. Fisher on Long Island violets in the *Plant World* (3: 91-92) for June, 1900. More explicit is a paper by James Kirby on "Some plants of Hempstead Plains" in the *American Botanist* (7: 110) for December, 1904 (published in May, 1905), which enumerates 14 species; about one third of which, however, do not properly belong to the prairie flora. In *Torrey* (6: 213) for October, 1906, a few species found in the same area by the Torrey Club excursionists on Sept. 1 are mentioned. In Dr. Harshberger's *Phytogeographic Survey of North America* (1911), page 421, is probably the most complete list of Hempstead Plains plants published up to that time, based on a walk of several miles through the area with the writer on Aug. 25, 1909.* By 1913 this prairie was sufficiently well known to plant sociologists to be featured as one of the attractions for the International Phytogeographic Excursion, most of the members of which visited it on July 27 of that year. Since then it has been on the regular field program of the summer classes in botany at Cold Spring Harbor. Taylor's *Flora of the Vicinity of New York* (1915) devotes nearly a page (29-30) to this area, and farther on, in the catalogue, eight species are recorded from the Hempstead Plains, besides a few weeds from Hempstead.

ENVIRONMENT

Area and topography. The area originally treeless was about fifty square miles, corresponding approximately with the Nassau County portions of the "Hempstead loam" and "Hempstead gravelly loam" as mapped in the government soil survey. (There seems to be no evidence that the areas of "Hempstead loam" in Kings and Suffolk counties were ever prairie.) By 1907 the area of natural vegetation had been reduced to about ten square miles, and probably at least a tenth of that has been destroyed since.

* A more extended account appears on pages 170-171 of "The vegetation of the New Jersey pine-barrens," by the same author (1916).

Although the soil is not particularly fertile, the proximity of New York City makes truck farming more or less profitable under adverse soil conditions, and also causes large areas to be used for residential purposes irrespective of soil.

The topography is nearly flat, as in many other prairies, but the surface has a southward slope of about 15 feet per mile, which is rather steep for a prairie, though almost imperceptible to the eye. Several shallow valleys traverse the area in a general north and south direction, and a few of these are long and deep enough to have small permanent streams in them. The western slopes of the valleys are nearly always steeper than the eastern, possibly on account of the deflective effect of the earth's rotation,* though the amount of erosion since the glacial period must be very small.

Geology and soil. The whole area is underlaid by a mixture of coarse sand and siliceous pebbles, supposed to represent a glacial outwash deposit, the terminal moraine being just to the north. At any rate, it is very recent geologically. The groundwater level averages perhaps 30 feet below the general level of the uplands, which explains the dryness of most of the valleys and some of the peculiarities of the vegetation.

The soil proper is very characteristic, consisting of brownish silty loam covering the gravel to a depth of about a foot, except in the valleys, where it is thin or wanting. A mechanical analysis of a sample representing the uppermost 10 inches, from two miles northeast of Hicksville, is reported in the government soil survey as follows:†

	Per cent
Gravel (2-1 mm.)	2.70
Coarse sand (1-.5 mm.)	8.06
Medium sand (.5-.25 mm.)	3.96
Fine sand (.25-.1 mm.)	4.88
Very fine sand (.1-.05 mm.)	8.96
Silt (.05-.005 mm.)	49.20

* See G. K. Gilbert, *Am. Jour. Sci.* 127: 431-432. 1884. Collier Cobb, *Jour. Elisha Mitchell Sci. Soc.*, 10: 26-32. 1893. C. F. Brooks, *School Sci. & Math.* 17: 517-521. 1917.

† All particles exceeding 2 mm. in diameter are discarded in these mechanical analyses, which probably does not make much difference in this particular case, but would make a great difference in the corresponding subsoil. For this reason the subsoil analysis given at the same place is not worth copying.

Clay (.005-.00001 mm.).....	22.20
Organic matter.....	8.26
Total.....	108.22

This has a higher percentage of organic matter than any other soil thus analyzed in the same report,* but this may mean merely that most of the other samples were taken from cultivated land, where the humus was long ago exhausted, for the virgin forests in the northwestern part of the island certainly have plenty of humus. Curiously enough, of all the mechanical analyses published for Long Island soils in the work mentioned, the one that matches this most closely is that of the "Galveston clay" (salt marsh) from two miles northeast of Far Rockaway. In fact the two analyses do not differ any more than two different ones of the same type of soil might be expected to. Whether or not this indicates that our prairie was once a salt marsh it is impossible to say; but, if it was, the surface must have undergone considerable tilting since, to give the Plains a southerly slope of one in 350; and it would not be very easy to explain why the prairie is separated from the present salt marshes by several miles of forest. It is possible also that some if not most of the soil has accumulated as dust in the course of centuries; but if that were the case it would be difficult to account for the absence of a dust layer in the surrounding forests, whose topography is very similar, and in many other level regions. Although the origin of the soil is not a botanical problem, this particular type of soil is so closely correlated with the prairie vegetation that one cannot help puzzling over it. No satisfactory explanation is available at the present writing, however.

A partial chemical analysis was reported in the first paper cited herein, and no additional information on that point has been obtained since. The amount of potash, one of the most important constituents, is entirely unknown. As elsewhere in the western half of Long Island, the soil fertility seems to increase a little toward the west, if the vegetation is a safe guide.

The small areas of bare ground between the tufts of herbage

* Dr. Hilgard found only 1 per cent of humus in a sample carefully selected by the writer about a mile southeast of Hicksville.

are generally covered with minute lichens* and an occasional patch of moss, which presumably indicates that earthworms are rare or absent, for if they were at all common the earth brought up by them and deposited on the surface would tend to bury these very slow-growing plants. The lack of earthworms is probably due to the fact that the loam layer is shallower than the depth to which the ground freezes in winter, and the worms if present would hardly descend into the gravel to hibernate. There are a few ants, but their hills are not numerous enough to interfere seriously with the ground lichens.

On account of the porosity of the subsoil every heavy rain must carry down into the ground some of the soluble salts, thus making the soil progressively poorer. And this tendency cannot be counteracted to any considerable extent by capillarity, on account of the depth of the water-table, or by the soil fauna (as it seems to be in some other places†), for the ants, etc., probably do not go down into the gravel much.

Climate. The climate is cool-temperate, but with a long growing season on account of the proximity of Long Island Sound and the Atlantic Ocean, neither of which is more than ten miles away. There are no weather stations on or very near the Plains, but if we take the average of the data for New York City, Setauket, and Brookhaven we will probably be not far wrong. The New York records were taken from 1826 to 1864 at Jamaica, which is within ten miles of the west end of the Plains, and since then on Manhattan Island, at a gradually increasing altitude as the buildings became taller. The Brookhaven records cover the period from 1864 to 1882, and those for Setauket from 1886 to 1909. The data given are the average temperature, in degrees Fahrenheit, and precipitation, in inches, for each month and for the whole year.

Months	Temperature	Precipitation
January.....	30.4	3.70
February.....	30.0	3.81
March.....	37.3	4.31
April.....	47.9	3.59

* Mostly *Cladonia symphycarpa epiphylla*, according to Mr. R. S. Williams, who identified a specimen for me recently. The moss is mostly *Polytrichum juniperinum*.

† See Ann. Rep. Fla. Geol. Surv. 7: 147. 1915.

May.....	58.7	3.69
June.....	67.8	3.02
July.....	73.3	4.04
August.....	71.7	4.14
September.....	65.5	3.47
October.....	54.8	3.84
November.....	44.1	3.85
December.....	34.5	3.83
Annual.....	51.3	45.28

The average growing season, or period free from killing frost, is from April 10 to November 7, 211 days. In this respect our area compares favorably with some places five hundred miles farther south, say in Georgia and Alabama. June is the driest month by a small margin, but it would be hard to find a place with a more evenly distributed precipitation. There are no accurate data on wind, sunshine, evaporation, humidity, or snowfall; but the average annual amount of the last is probably something like two or three feet.

VEGETATION

Habitats. The natural vegetation may be divided into two habitat groups: that of uplands and that along watercourses. In a more detailed study the gravelly slopes of the valleys with the beds of the dry ones might make a third group, but the vegetation of such places, though differing a little in composition, is so similar in aspect to that of the level uplands that it is hardly worth while to separate it. There is also a characteristic weed vegetation along roads and in abandoned fields, which will be discussed briefly farther on. The upland vegetation is by far the most extensive, but that of the valleys is (or was) a little richer in species. The next few pages will deal with the natural upland vegetation exclusively, unless otherwise indicated.

Aspects. The prevailing aspect of the vegetation is a moderately dense growth of coarse grasses and other herbs, averaging about two feet tall, with a sprinkling of shrubs of about the same height, and a few trees, either solitary or in small open groves. All the woody plants are most abundant eastward, except the commonest shrub, which is pretty uniformly distributed. There are no stout broad-leaved herbs like the *Silphiums* of the Middle Western prairies, but on the other hand there are few evergreens

or succulents. The prevailing color of the herbage in summer is grayish green, on account of the prevalence of glaucous and canescent leaves,* but the scene is brightened by flowers of various colors, changing from month to month as in many other grasslands and the southeastern pine-barrens. In the fall, the color gradually changes to light brown, with a strong shading of gray from the plumose spikelets of the prevailing grass (which grows on nearly every square foot of upland, and makes up something like three fourths of the total herbaceous vegetation).

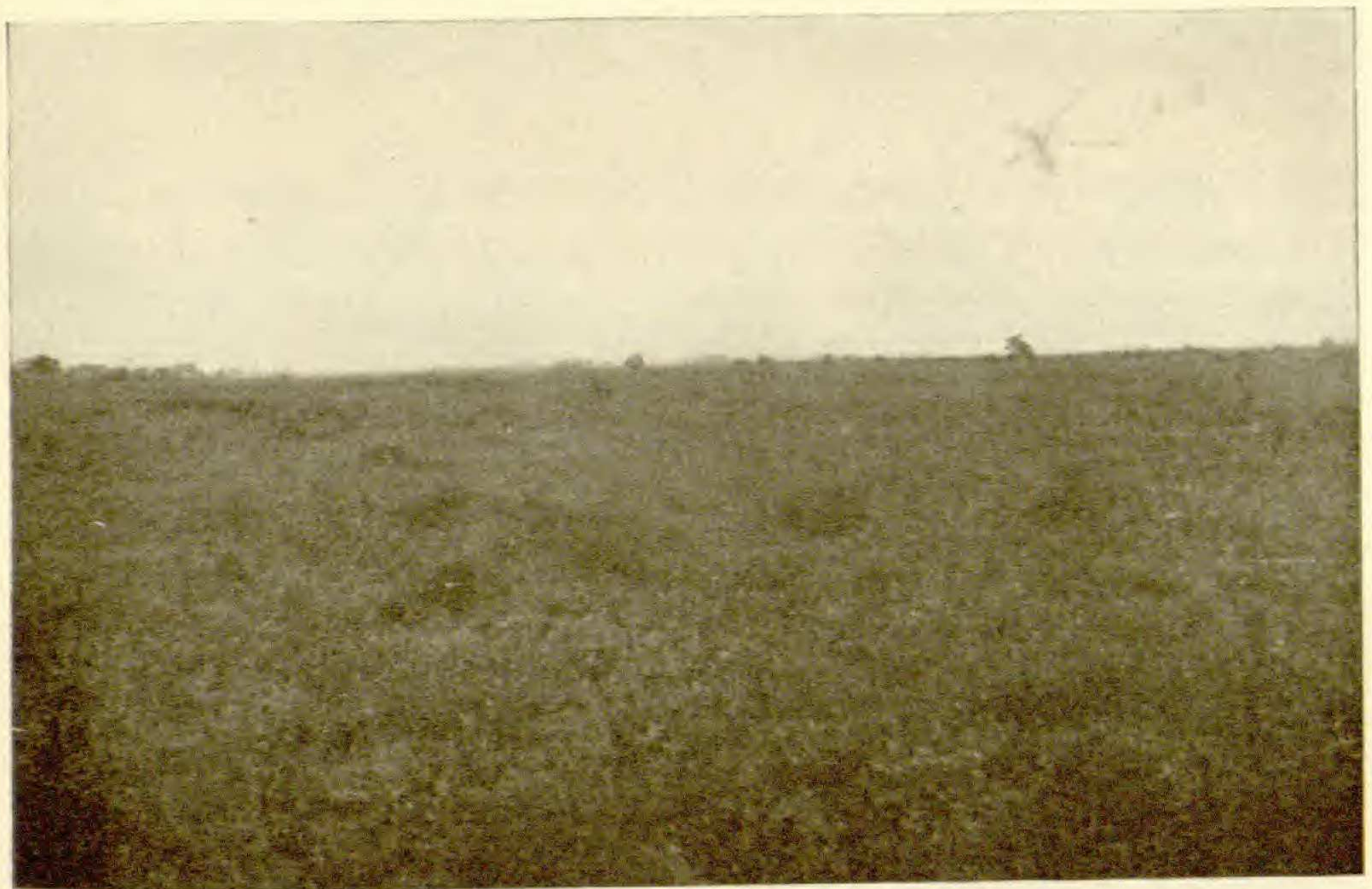


FIG. 1. Typical prairie scene about $1\frac{1}{4}$ miles northeast of Hicksville, looking south. *Andropogon* and *Baptisia* in foreground, farm-house and a few shade-trees in middle distance, and edge of forest barely visible on the horizon. 2:05 p.m., Oct. 20, 1907.

On account of the small size of this prairie one could stand at any point on the upland and see the surrounding forests in every direction if buildings and shade-trees did not interfere; but in the western part one can step down into one of the shallow valleys and get an absolutely treeless horizon in some directions, indistinguishable in a photograph from some places far out on the Great Plains.†

* In this connection see Wiegand, Bot. Gaz. 49: 430-444. 1910.

† See PLATE 7, and compare this with a scene in western Kansas published in Bull. Am. Geog. Soc. 40: 338. June, 1908.

Fire. Fire seems to be a normal environmental factor in this prairie, as in all others more than a few acres in extent,* but just what its normal frequency may have been in prehistoric times it is impossible now to determine. Nearly all the herbs and shrubs have thick or matted subterranean rootstocks, so that they sprout up again readily after a fire. Plants with barbed fruits (which are most effective in dissemination if they remain on the plant for several months) seem to be entirely absent, and shrubs with nuts or berries generally grow in clumps, whose centers are thus



FIG. 2. Edge of oak grove near the railroad, about two miles north of Hicksville, looking S.S.E., showing *Quercus Marylandica*, *Q. stellata*, and the herbaceous vegetation characteristic of dry prairies. 12:20 p.m., Oct. 20, 1907. The trees evidently have, and need, little or no protection from fire running through the grass. (The view in Torrey's 12: 282 was taken from the same point.)

protected from fires of moderate intensity. Woody vines (all of which seem to be sensitive to fire) are scarce, and chiefly confined to the clumps of bushes in the eastern part and to the valleys. The commonest tree on the Plains, the gray birch, is often partly protected by a cluster of shoots around its base, and it is rather short-lived anyway, so that young trees spring up as

* See Plant World 20: 60. "Feb." 1917.

fast as the older ones are killed by fire. The pines and oaks scattered over the eastern part of the Plains are of species not very sensitive to fire, so that they do not need to grow in dense groves for protection, like the prairie groves of the Mississippi valley.* The original boundary between prairie and forest here has been almost entirely obliterated by cultivation, but it was probably rather sharp in most places, for the regular forest trees of Nassau County, both north and south of the Plains, are mostly of species not very tolerant of fire, and the fires probably stopped



FIG. 3. Portion of pine grove ("Island of Trees") in prairie about a mile southwest of Central Park, showing especially *Pinus rigida* and *Baptisia tinctoria*. 2:47 p.m., Aug. 25, 1909. In the absence of shrubby undergrowth this place differs notably from the pine-barrens of Long Island and New Jersey, and resembles some of those in the southeastern states. (For another view of the same grove see Bull. Am. Geog. Soc. 43: 359.)

abruptly at the edge of the forest, where the shade kept the humus too damp to burn readily.

It seems rather strange for the ground to be covered with lichens and sprinkled with mosses in an area subject to ground fires, for these plants are supposed to be very sensitive to fire; but probably any one spot on the uplands does not get burned over more than once in two years, on the average. And the commonest lichen is so minute and close to the ground that fire

* See Gleason, Bot. Gaz. 53: 38-49. 1912; Torreyia 13: 173-181. 1913.

jumping from one tuft of grass to another may pass over it without doing much injury, and the mosses and fruticose lichens are mostly in gravelly places, where the vegetation is too sparse to make much of a blaze.

The vegetation of the wet valleys seems to be practically exempt from fire.

Plant census. The approximate relative abundance of the species has been ascertained by a rapid reconnoissance method which is a crude modification of Clements's quadrant method. I have traversed the area on foot repeatedly in every direction (mostly in the summers and falls of 1907 to 1909, with a few additional observations made in passing through in 1916 and 1917), and in so doing have stopped every few yards or rods and jotted down the name of every plant in sight, indicating relative abundance by a somewhat arbitrary scale. When hundreds of such little lists are combined they ought to give the relative abundance (combined with size and duration) of the species pretty accurately, for the largest and most abundant species of course are noted oftenest. Herbs which are recognizable only during a brief period when they bloom naturally do not figure as largely in the returns as the more lasting ones, but that is all right, for the ephemeral species do not take as much water, etc., from the soil and make as much hay as the others.

On account of the difficulty of making proper allowance for plants of different sizes, ranging all the way from lichens to trees, and the great preponderance of one species among the herbs, I have not ventured to assign percentages to the several species. But when the percentages are finally worked out and arranged in numerical order they will probably make something like a geometrical progression, for in all areas of natural vegetation that are large and homogeneous enough there seem to be many more small and rare species than large and abundant ones; just as in human society there are always more insignificant people than celebrities, more poor men than millionaires, or more small towns than large cities.

In the following lists trees, shrubs, herbs, and cellular cryptogams are separated, and arranged in order of abundance in each group, as usual. A few of those seen least often are omitted, on

account of the considerable possibility that they may have been introduced, or wrongly identified. The names of evergreens are in heavier type, and those of a few species of weedy tendencies, which may not have been in the prairie in prehistoric times, are put in parentheses.

The nomenclature is in most cases identical with that in Taylor's Flora of the vicinity of New York (1915); and where it differs from that it conforms with other easily accessible works. After the name of each species is put the numbers of the months in which it normally blooms, the prevailing color of its flowers (replaced by a dash in the case of wind-pollinated species which have no organs for attracting insects), and a symbol indicating the mode of dissemination, when known. Wind-disseminated species (including tumble-weeds) are indicated by Y, tonoboles* (i. e., plants with capsules or firm cup-like calyces borne on stiff stems which stand up through the winter) by T, berries and nuts by O, and pods which discharge their seeds by elastic force by E. One could go still farther and have symbols or abbreviations for annuals and perennials, the Raunkiaerian growth-forms, various types of leaf, etc.,† but it is just as well not to undertake too much at one time, and some of these matters—as well as the authors' names, common names, phaenological curves, etc.—can very well be deferred to a more exhaustive study of the flora.

The first list is for uplands and dry valleys.

TREES

<i>Betula populifolia</i>	5 —	Y
<i>Quercus marylandica</i>	5 —	O
<i>Quercus stellata</i>	5 —	O
<i>Pinus rigida</i>	5 —	Y

SHRUBS

<i>Pieris Mariana</i>	5-7 white	T
<i>Salix tristis</i> (?)‡	4 —	Y
<i>Quercus prinoides</i>	5 —	O
(<i>Populus tremuloides</i>)§	4 —	Y

* See Clements, Bot. Surv. Neb. 7: 47. 1904.

† See Ann. N. Y. Acad. Sci. 17: 36-38 (1906) for a more elaborate method of treating plant association lists.

‡ This could just about as well be *S. humilis*. No one seems to have succeeded in drawing a sharp line between the two forms.

§ This is normally a small tree, but on the Hempstead Plains it seldom gets more than three or four feet tall, perhaps on account of the frequent fires.

<i>Gaylussacia baccata</i>	5 pink O
<i>Comptonia peregrina</i>	5 —
<i>Rhus copallina</i>	7-8 yellow O
<i>Myrica carolinensis</i>	5 — O
<i>Quercus ilicifolia</i>	5 — O
<i>Corylus americana</i>	4 — O
(<i>Rubus cuneifolius</i>).....	5-7 white O

HERBS

<i>Andropogon scoparius</i>	8-9 — Y
<i>Ionactis linariifolius</i>	9-10 blue Y
<i>Baptisia tinctoria</i>	6-9 yellow Y
<i>Aster dumosus strictior</i>	9-10 white Y
<i>Crocanthemum</i> sp.*.....	5-8 yellow
<i>Cracca virginiana</i>	6 cream and purple E
<i>Aletris farinosa</i>	6-7 white T
<i>Viola pedata</i>	5 blue E
<i>Solidago puberula</i> (?)†.....	9-11 yellow Y
<i>Antennaria neglecta</i>	4-5 white Y
<i>Agalinis acuta</i> ‡.....	9 pink-purple T
<i>Lespedeza capitata sericea</i>	8-9 cream 5
<i>Juncus Greenei</i>	6 green T
<i>Lechea villosa</i>	7-8 dark purple T
(<i>Euthamia tenuifolia</i>).....	9-10 yellow Y
<i>Scleria pauciflora</i>	6-7 —
<i>Sorghastrum nutans</i>	9 —
<i>Sisyrinchium</i> sp.....	5-6 blue
<i>Linum intercursum</i> §.....	7-8 yellow T
<i>Polygala Nuttallii</i>	7-9 pink
<i>Hypoxis hirsuta</i>	5-6 yellow
<i>Lechea maritima</i>	7-8 dark purple T
(<i>Potentilla canadensis</i>).....	5 yellow
<i>Sericocarpus linifolius</i>	7-8 white Y
(<i>Agrostis alba</i> ?).....	5-6 — Y
<i>Polygala viridescens</i>	8-9 pink
<i>Carex pennsylvanica</i>	4-5 —
<i>Lespedeza angustifolia</i>	8-9 cream T
<i>Eupatorium hyssopifolium</i>	8-10 white Y
<i>Viola fimbriatula</i>	4-5 blue E
<i>Cirsium discolor</i> (?).....	6-7 pink-purple Y
<i>Polygala polygama</i>	6-8 pink-purple
<i>Andropogon furcatus</i>	9 — Y

* There may be more than one *Crocanthemum* (long known as *Helianthemum*), in which case both would take a lower rank in the list. See Bicknell, Bull. Torrey Club 40: 613-615. 1913. Fernald, Rhodora 19: 58-60. 1917.

† Some *S. nemoralis* may have been included with this.

‡ Described since Taylor's Flora, in Bull. Torrey Club 42: 338-340. June, 1915. Formerly referred to *Gerardia decemloba*, a species of more southerly range.

§ Bicknell, Bull. Torrey Club 39: 418. 1912. Previously confused with *L. medium* or *L. floridanum*. See also C. A. Weatherby, Rhodora 18: 224. 1916.

<i>Bartonia virginica</i>	8-9 cream
<i>Viola lanceolata</i>	5 blue E
<i>Houstonia longifolia</i>	5-6 pink-purple T
(<i>Sarothra gentianoides</i>).....	8-9 yellow
<i>Antennaria plantaginifolia</i>	4-5 white Y
<i>Comandra umbellata</i>	5-6 white
<i>Ibidium gracile</i>	8-9 white

CRYPTOGAMS

Cladonia symphycarpa epiphylla (and others)

Polytrichum juniperinum

Boletus sp.

As in many other parts of the country, the trees all have vernal wind-pollinated flowers, and the same is true of most of the shrubs. Among the herbs the commonest species is wind-pollinated, but most of the others have yellow, white, or blue flowers (with little or no odor). There are more herbaceous flowers in spring than in midsummer, and more in fall than in spring, at least if we consider species regardless of their relative abundance. Plumose seeds or fruits prevail among the herbs, but "tonoboles" are quite common also. None of the herbs seem to have fleshy fruits, but the nut-like fruits of *Comandra* may be eaten by small mammals. Some of the smaller herbs, particularly the Polygalas, have appendaged seeds which are thought to be adapted to transportation by ants.

Some dynamic studies of the upland vegetation were made in 1916. On Oct. 27, about a mile S.S.E. of Westbury Station, a typical sample of herbaceous vegetation, consisting chiefly of *Andropogon scoparius* (which constitutes the bulk of the herbage of the Plains) was cut close to the ground from a small measured area, so as to get the total annual growth per unit area, exclusive of a small amount of stubble and roots. It weighed 8,220 pounds per acre at the time, but then growth had probably ceased and the drying out begun, so that if it had been cut a month earlier the weight might have been greater. The same vegetation when air-dry weighed 5,975 pounds per acre, which is probably less than the average annual increment of vegetation in the eastern United States, though much higher than figures obtained by Shantz for somewhat similar vegetation in eastern Colorado.*

* U. S. Bur. Plant Industry Bull. 201: 81. 1911.

The ash weighed 265 pounds per acre, or between 4 and 5 per cent of the air-dry weight.

According to some of the old inhabitants, the Plains vegetation formerly grew taller than it does now. This probably does not mean that the *Andropogon scoparius* was any taller, but that the taller grasses, such as *A. furcatus* and *Sorghastrum* (which are said to be more characteristic of the fertile prairies of the West), were more abundant. If that is true the annual growth per unit area must be decreasing, which is consistent with the suggestion on a preceding page about the progressive impoverishment of the soil. And the fact that the groves of pines at Island of Trees are composed of rather small trees appears to indicate a comparatively recent invasion, which would be in harmony with the same tendency, for *Pinus rigida*, like most other pines, flourishes in very poor soils. But one would hardly suppose that the soil could deteriorate so rapidly that the difference in vegetation would be noticeable in a lifetime, and there may be some entirely different explanation for the supposed change in vegetation.

The vegetation characteristic of the wet valleys is very limited in extent. The largest stream on the Plains is East Meadow Brook, which rises about three miles east of Garden City and flows south about a mile before passing into the forest region. Most of its vegetation within the prairie area has been destroyed in the last few years, unfortunately, and the brook itself is nearly dry now, but pretty full notes were taken there in 1907-1909. Hempstead Brook, which flows through the eastern part of the village of Hempstead, is next in importance, and there is a smaller brook about two miles farther west which still has a trace of its original vegetation.

Along the streams there are no trees except a few small specimens of *Acer rubrum* and *Nyssa*, scarcely rising above the shrubbery, but the shrubs are considerably larger than those of the uplands, many of them being higher than a man's head. Fire seems to be a negligible factor in the environment.

The meadow plants are divided into small trees and shrubs, vines and undershrubs, herbs and mosses. Otherwise the treatment is the same as that of the upland vegetation, the rarer species being omitted, for the reasons already given.

SMALL TREES AND SHRUBS

<i>Rhus Vernix</i>	6-7 cream	O
<i>Myrica carolinensis</i>	5 —	O
<i>Viburnum dentatum</i>	5-6 white	O
<i>Rosa palustris</i>	6 pink-purple	
<i>Cholisma ligustrina</i>	6-7 white	
<i>Spiraea latifolia</i>	6-7 white	
<i>Aronia nigra</i>	5 white	O
<i>Spiraea tomentosa</i>	7 pink-purple	
<i>Pieris Mariana</i>	5-7 white	
<i>Sambucus canadensis</i>	6-7 white	O
<i>Vaccinium corymbosum?</i>	5 white	O
<i>Acer rubrum</i>	4 red	Y

VINES AND UNDERSHRUBS

<i>Rubus hispidus</i>	6-7 white	O
<i>Rhus radicans</i>	5-6 cream	O
<i>Oxycoccus macrocarpus</i>	6-8 pink	O

HERBS

<i>Dulichium arundinaceum</i>	6-8 —	
<i>Lycopus</i> sp.....	8-9 white	T
<i>Hypericum adpressum</i>	7 yellow	T
<i>Vernonia noveboracensis</i>	7-9 purple	Y
<i>Osmunda cinnamomea</i>		
<i>Eupatorium perfoliatum</i>	8-9 white	Y
<i>Panicum virgatum</i>	7-8 —	
<i>Juncus canadensis?</i>	7-8 green	T
<i>Dryopteris Thelypteris</i>		
<i>Lysimachia terrestris</i>	6-8 yellow	
<i>Kneiffia linearis?</i>	6-8 yellow*	
<i>Eriophorum gracile?</i>	5 —	Y
<i>Rhynchospora alba</i>	7-8 white	
<i>Polygala cruciata</i>	7-9 pink	
<i>Eriocaulon septangulare</i>	7-9 white	
<i>Rhexia virginica</i>	7-9 pink-purple	T
<i>Polygonum sagittatum</i>	6-10 white	
<i>Triadenum virginicum</i>	7-9 pink-purple	T
<i>Gentiana Saponaria</i>	9-11 blue	T
<i>Sparganium</i> sp.....	7-8 —	
<i>Linum striatum</i>	7-8 yellow	
<i>Viola primulifolia</i>	5 white	E
<i>Juncus acuminatus?</i>	6-8 green	T
<i>Helianthus angustifolius</i>	8-9 yellow	
<i>Onoclea sensibilis</i>		
<i>Osmunda regalis</i>		

* See Plant World 8: 301-303. 1906. In that paper the false common name "evening primrose," which belongs to the related genus *Oenothera* but decidedly not to *Kneiffia*, was inserted by the editors without the writer's knowledge or consent. The figures are four times natural size.

<i>Agalinis purpurea</i>	8-10 pink-purple	T
<i>Viola lanceolata</i>	5 white	E
<i>Gratiola aurea</i>	6-7 yellow	
<i>Xyris</i> sp.	7-9 yellow	T
<i>Ludwigia alternifolia</i>	6-8 yellow	T
<i>Carex sterilis?</i>	5 —	
<i>Eriophorum virginicum</i>	7 —	Y
<i>Eupatorium purpureum</i>	6-8 pink-purple	Y
<i>Castalia odorata</i>	6-9 white	
<i>Asclepias pulchra</i>	7-8 pink-purple	Y
<i>Rhynchospora glomerata</i>	6-8 —	
<i>Euthamia tenuifolia</i>	8-10 yellow	Y
<i>Drosera intermedia</i>	6-8 pink-purple	
<i>Potamogeton</i> sp.	7 —	
<i>Hypericum canadense</i>	7-9 yellow	T
<i>Carex lurida</i>	5 —	
<i>Solidago rugosa</i>	8-10 yellow	Y
<i>Sagittaria latifolia</i>	8-9 white	
<i>Eleocharis melanocarpa</i>	6-7 —	
<i>Aster salicifolius?</i>	9 blue	Y
<i>Lycopodium adpressum</i>		
<i>Lobelia Nuttallii</i>	7-9 blue	
<i>Ibidium cernuum</i>	9-10 white	Y
<i>Aletris farinosa</i>	6-7 white	T
<i>Juncus Greenei</i>	6 green	T

MOSSES

Sphagnum sp. (perhaps more than one)

The majority of the shrubs and vines bloom in early summer and have white flowers and fleshy fruits. Among the herbs the proportion of aestival pink-purple flowers, and of tonoboles, is noticeably larger than on the uplands, and there are few or no fleshy fruits. There are, however, many species whose mode of dissemination is not certainly known.* Some of these doubtless have seeds that float downstream, and are carried in other directions on the feet of aquatic birds. The shrubs that bear capsules are perhaps to be classed as tonoboles.

Weeds. Many of the roads across the Plains are entirely unimproved, mere wheel-tracks, which are shifted a little from time to time as the ruts become too deep, in precisely the same manner as some of those in eastern Colorado described recently by Shantz.† Along almost every such road can be found *Euthamia*

* See Torrey 8: 159. 1908.

† Jour. Ecology 5: 19-42. f. 1-23. March, 1917. Several of the illustrations in that paper could be matched very closely on the Hempstead Plains, and much of the text would apply very well too, except for the names of the plants discussed.

tenuifolia, which may be native in some parts of the eastern United States, but nearly always grows in places whose naturalness is not above suspicion, all the way from here to Florida. *Agrostis alba* is very common also along roads, and most of the other species whose names are in parentheses in the upland vegetation list grow in similar places, where the original vegetation has been damaged without much disturbance of the soil. None of them seem to invade undisturbed vegetation, however.

Where the soil has once been plowed up and cultivated many additional weeds, such as *Oenothera biennis*, *Ambrosia artemisiifolia*, *Persicaria* sp., *Linaria vulgaris*, *Daucus Carota*, *Syntherisma sanguinalis*, and *Aster ericoides*, come in, and these seem able to hold the ground indefinitely against a re-invasion by native species. Very little attention has been paid to this particular phenomenon as yet, but there will be time enough for it after the natural vegetation, which needs more immediate attention, is all gone.

COMPARISONS WITH OTHER REGIONS

There is no precisely similar vegetation anywhere else, as far as known, but there are many places near and remote with vegetation somewhat similar in aspect or composition, or both. Among the nearer places are the so-called heaths of Nantucket, described by Harshberger,* and Block Island, Montauk Point, and various other places near the coast of southern New England, if we may judge by the few photographs and fragmentary floristic descriptions that have been published, though in some of these cases the treelessness is said to be the result of deforestation within historic times.

The "hilltop barren formation" of eastern Massachusetts, described by Blankinship,† has quite a number of species in common with the area under consideration. In the government soil survey of Rhode Island by F. E. Bonsteel and E. P. Carr, published in 1905, there is described a "Miami silt loam,"‡ occurring principally in the township of South Kingstown, in the

* Bull. Geog. Soc. Phila. 12: 73-76. 1914.

† Rhodora 5: 128. May, 1903.

‡ In a subsequent publication of the Bureau of Soils this was changed to "Merri-mac silt loam," a type of soil not reported outside of Rhode Island, and classed as a glacial lake deposit.

southern part of the state, which must be very similar to the "Hempstead loam," the principal differences brought out in the description being that the sand and gravel begin about three feet below the surface instead of one, and the ground-water level is much nearer the surface, sometimes rising above it in rainy weather or when snow is melting rapidly. The soil survey report says little or nothing about the vegetation, but in *Rhodora* (9: 117-122) for July, 1907, there is a paper on The flora of the Great Swamp of Rhode Island, by E. S. Reynolds, which throws some light on the subject. The Great Swamp, which borders Worden's Pond, is immediately south of the "Miami silt loam" areas, and Reynolds's list includes quite a number of species which are certainly not swamp plants, and may have come from the silt loam area, though habitats and localities (and abundance) are not indicated. Species previously collected by others in the same neighborhood are excluded from his list, and the reader is given no intimation of what those might be, except that they are about as numerous as those listed. Under the circumstances, therefore, it is interesting to find in Reynolds's list the following which are characteristic of the upland vegetation of the Hempstead Plains (taking them in the same order in which they appear in the present paper): *Rhus copallina*, *Baptisia tinctoria*, *Viola pedata*, *Solidago puberula*, *Lespedeza capitata*, *Hypoxis*, *Bartonia virginica*, *Ibidium* (*Spiranthes*) *gracile*. And it is reasonably certain that among the species collected by others and therefore ignored by Reynolds there are other typical Hempstead Plains plants*. The similarity of his list to our meadow vegetation is of course much closer, as he was ostensibly dealing with swamp plants only.

The sand-plains of North Haven, Connecticut, described by W. E. Britton,† also have many of the same species as our area, and Dr. G. E. Nichols has sent me photographs of parts of those sand-plains where the herbage was denser than any figured by Dr. Britton, and appeared much like that of the Hempstead Plains. The sand barrens of southern Staten Island, according to S. H. Burnham,‡ are likewise characterized by some of the same species.

*For example, Fernald, in *Rhodora* 19: 58, reports *Crocanthemum dumosum* from South Kingstown.

† Bull. Torrey Club 30: 571-620. pl. 23-28. 1903.

‡ Torrey 13: 249-255. Nov. 1913.

Other marked similarities to our area, floristic or vegetational, are found in the serpentine barrens of Pennsylvania and Maryland, discussed by Harshberger,* Pennell,† and Shreve,‡ and the sand areas of Illinois, described by Gleason and others.§ (The typical Illinois prairies, however, have much richer soil and more luxuriant vegetation, with more broad-leaved herbs and almost no shrubs.)

Still farther west we can find a number of resemblances in the sand-hills of western Nebraska, described by Rydberg|| and Pool.¶ The less typical sand-hills of northeastern Colorado, visited by the writer under the guidance of Dr. Shantz in August, 1915, are probably more like the Hempstead Plains than are those of Nebraska, for the vegetative covering is more continuous. The dominant grass on the Colorado sand-hills is the same as on the Hempstead Plains (or at least taxonomists have not yet separated them). The regular short-grass prairie in the same neighborhood also has some features in common with that under discussion. Instead of our *Baptisia tinctoria* there is another leguminous plant of much the same aspect, namely, *Psoralea tenuiflora*** The similarity of roadside conditions there and on Long Island has already been mentioned under the head of weeds.

The gravelly prairies south of Puget Sound, described by Piper,†† resemble ours in being level and grassy, with scattered oaks, and even have a species of *Sericocarpus*, the only member of the genus that grows outside of the eastern United States.

Considering briefly the southeastern states, the dry fields of Middle Georgia have several of the same plants as the Hempstead Plains uplands, and the prairie meadow plants are pretty well

* Science II. 18: 339-343. Sept. 11, 1903.

† Proc. Acad. Nat. Sci. Phila. 62: 541-584. 1911; 64: 520-539. 1913.

‡ Plant Life of Md. 213-215. pl. 20. 1910. The writer had opportunity to visit some of the well-known serpentine barrens near Baltimore and Philadelphia in June, 1917. An early description, primarily mineralogical, of those nearest Baltimore is by Dr. H. H. Hayden in Am. Jour. Sci. 24: 349-360. 1833.

§ Bull. Ill. State Lab. Nat. Hist. 7: 149-194. Jan. 1907; 9: 23-174. pl. 1-20. 1910.

|| Contr. U. S. Nat. Herb. 3: 133-200. pl. 1, 2. 1895.

¶ Minn. Bot. Stud. 4: 189-312. pl. 26-40. 1914. Reviewed in Bull. Am. Geog. Soc. 47: 873-874. Nov. 1915.

** For descriptions of prairie vegetation in Colorado, see Shantz, U. S. Bur. Pl. Ind. Bull. 201, 1911; particularly, plate 3, fig. 1, and plate 4, fig. 1.

†† Contr. U. S. Nat. Herb. 11: 42-44. pl. 9, 10. 1906.

represented in the meadows of the same neighborhood, and also in western North Carolina, though these southern grass-lands may have once been wooded.*

Lastly, by way of contrast, we may consider the pine-barrens of Long Island, which begin immediately east of the Plains. The flora of the two regions has much in common, but the vegetation is very different.† There are also some differences between representatives of the same species in the two areas, which may possibly hereafter be made the basis of subspecific distinctions. For example, *Quercus prinoides* on the prairie has nearly simple stems in large clumps, with broader, thinner, and paler leaves than in the pine-barrens; and *Sericocarpus linifolius* has broader and more numerous leaves on the prairie, presumably indicating better soil, notwithstanding the greater exposure to sun and wind, which ought to have just the opposite effect on leaves, if other factors were equal. Of the two shrubby oaks characteristic of both places, *Quercus ilicifolia* outnumbers *Q. prinoides* at least ten to one in the pine-barrens, while on the Plains the latter is at least twice as abundant as the former.

A discussion of the geographical affinities of the flora, the families and genera most numerous represented or conspicuous by their absence, etc., belongs more properly to a floristic paper. But it may be noted in passing that most of the upland species are widely distributed in sunny places, on rather poor soils, in the northeastern United States south of the boreal conifer region, and almost none of them are found in Europe or near the Pacific coast. Few if any are confined to the coastal plain. The two arborescent oaks, one of which reaches its northeastern limit here, while the other extends to Massachusetts, have been seen by the writer, or are reported by others to occur, usually together, on the coast of New Jersey, on the edges of the serpentine barrens of Pennsylvania and Maryland and dry prairies in Illinois, Missouri, and Arkansas, around flat rock outcrops in Georgia and Alabama, in the prairies, flatwoods, and barrens of Alabama and Mississippi, and lastly in the "cross-timbers" of Oklahoma and Texas, where they are said to constitute the bulk of the forest. Both reach

* See Bull. Torrey Club 27: 322, 327. 1900; Torreya 10: 63. 1910.

† See Torreya 8: 1-9. 1908.

their southern limits in the northern edge of Florida, as do some of the other plants under consideration.

Among the most widely distributed members of the upland vegetation, besides the two oaks just mentioned, are *Rhus copallina*, *Andropogon scoparius*, *Cracca virginiana*, *Aletris farinosa*, *Viola pedata*, *Sorghastrum nutans*, *Hypoxis hirsuta*, *Carex pennsylvanica*, *Polygala polygama*, *Andropogon furcatus*, and *Antennaria plantaginifolia*; while some of the most local are *Aster dumosus strictior*, *Crocanthemum dumosum*, *Agalinis acuta*, *Juncus Greenei*, and *Linum intercursum*. (These last are all reported also from Nantucket Island.) The species which are probably more abundant here than in any other equal area in the world, in addition to the five last named, are *Pieris Mariana*, *Quercus prinoides*, *Andropogon scoparius*, *Ionactis*, *Baptisia tinctoria*, *Viola pedata*, *Antennaria neglecta*, *Lespedeza capitata sericea*, *Scleria pauciflora*, *Sericocarpus linifolius*, *Lespedeza angustifolia*, and *Eupatorium hyssopifolium*.*

The meadow plants are more widely distributed, on the whole, than those of the uplands, most of them ranging from Canada to Georgia at least.

DESTRUCTIVE INFLUENCES

Finally the influences tending to destroy the prairie vegetation may be reviewed briefly. When the neighborhood was first settled, in the seventeenth century, it was soon discovered that the Hempstead Plains was not very well adapted to agriculture, and for a century or two the greater part of it was treated as public property or free pasture, much as unfenced land in the more thinly settled states is today. Grazing has continued in a small way down to the present time, but the area has probably never been overgrazed sufficiently to weaken the native vegetation and allow weeds to enter, except in enclosures near dwellings.

The absence of trees and rocks and hills made cultivation very easy, however, so that some farms were established on the Plains at an early date in spite of the poverty of the soil (which could be counteracted to some extent with manure, etc.), to supply

* Future species-splitting may require modification of some of the statements in this paragraph, but apart from that they can hardly be challenged until the vegetation of a number of other areas is studied quantitatively.

the surrounding villages, before easy railroad communication with the interior of the country made it more economical to bring part of the food supply from the more fertile lands of the West. Agriculture on the Plains, as elsewhere on Long Island, probably reached its maximum extension two or three generations ago. Census statistics for Nassau County go back only to 1900, for it was not separated from Queens until 1899, but the number of farms in the county decreased from 1,658 in 1900 to 1,017 in 1910, and the acreage of farm land decreased during the same period from a little over half the total area to less than a third, and is doubtless still less now.* But prairie land once cultivated and afterwards abandoned seems never to revert to the original vegetation, as pointed out under the head of weeds; or at least if it does the process is so slow that no evidences of it have yet been discovered.

At the present time more of the land is used for residential purposes than for agriculture, the proximity of New York City and the ease of communication causing many people to settle on and around the Plains quite independently of soil conditions. Nassau County had 202 inhabitants per square mile in 1900 and 303 in 1910, and probably has about 400 now. Although this causes considerable encroachment on the prairie and may be the ultimate means of obliterating it, in a way it tends to protect it from agricultural exploitation, for it makes some of the land too valuable for farmers to touch, just as there is said to be more natural prairie now inside the city of Chicago than for a considerable distance outside, for a similar reason.

A more serious menace at the present time is the appropriation of considerable areas for pleasure purposes, such as polo and golf; the latter having brought about the destruction of most of the Meadow Brook vegetation a few years ago, causing keen regret to nature-lovers. For there are innumerable suitable sites for golf

* There was less than half as much farm land and only a little more than half as much cultivated land, on Long Island in 1910 as in 1850, when such statistics were first included in the census. The farmers are evidently being crowded out by commuters and millionaires. In the last few years the Garden City Company, perhaps unmindful of the rapid decline of farming on Long Island and the futility of trying to counteract it, has plowed up several hundred acres of virgin prairie by machinery and offered to lease the land to farmers (see news item at bottom of page 113 of *Torreyana* for June, 1914), but apparently without much success.

links, but only one Meadow Brook. (The name East Meadow Brook does not necessarily imply that there were two, but was probably applied originally simply to designate the brook flowing through the East Meadow: i. e., east of Hempstead.)

During the Spanish-American war in 1898 some of our soldiers were encamped on the Plains near Mineola (Camp Black), and in 1917 a much larger encampment (Camp Mills) was located east of Garden City and Hempstead, causing the trampling down or otherwise injuring of about a square mile of vegetation, which will probably never fully recover.*

When the aëroplane became an accomplished fact, in 1909, the Hempstead Plains was very soon selected as an ideal place to experiment with the new means of locomotion, on account of the large flat area comparatively free from obstructions, and its proximity to our largest city. The necessary buildings and regular alighting places have encroached on the prairie a little near Mineola, but otherwise this industry has done little damage; and it probably deserves the good wishes of botanists, for it is decidedly to the interest of the aviators that no more of the Plains should be cultivated or built upon. There was indeed once a little complaint from them that the surface was a little too rough (from the tufts of grass, no doubt), and should be smoothed, but they have apparently become reconciled to that.

Let us hope that the State or the federal government or some public-spirited organization will soon take steps to preserve the rest of this unique and easily accessible prairie permanently from further encroachments, for the benefit of aviators, even if the interests of plant sociologists and other nature-lovers are not considered at all in these days of commercialism. But if it comes to the worst the southeastern corner of the Plains, which is remotest from settlements, will probably have some of its natural vegetation still in condition for study two or three generations hence, and some important ecological principles may yet be discovered there.

* A news item sent from Camp Mills to the daily papers on Oct. 21, 1917, mentioned the menacing of the camp by a prairie fire; something that some of the western soldiers may have been familiar with, but could hardly have expected to see so near the metropolis.

At least four other chapters should be written about this unique area by competent persons before it is too late: one on its geology, with special reference to the origin of the soil; one on its flora, with attention to the points mentioned on pages 273 and 282, and others easily called to mind; one on its fauna; and one on its agricultural and economic history.

EXPLANATION OF PLATE 7

Looking southeast in dry valley at head of Hempstead Brook, about $1\frac{1}{2}$ miles east of Garden City, showing treeless horizon about $\frac{1}{4}$ mile away. The view embraces a horizontal angle of about 40° . (There was no house within a mile of this spot, but if the camera—which was about four feet from the ground—had been raised a few feet, some buildings and planted trees would have appeared in the view.) Taken in a gentle rain at 4 p.m., Oct. 27, 1907. (For other views taken near the same place see Bull. Am. Geog. Soc. 43: 352; Torrey 12: 279. The most conspicuous plant in the foreground of the former, not there designated, is *Eupatorium hyssopifolium*.) Ten years later this place was included in the site of Camp Mills, and its appearance greatly altered; so that there will probably never again be an opportunity to take such a photograph on Long Island.

ADDENDA (March, 1918)

P. 276. The tradition is, Mr. Henry Hicks tells me, that a century or more ago a man crossing the Plains on horseback on a dewy morning would be wet to his waist; which seems to indicate that much of the grass was five or six feet tall. This is not at all improbable, for a news item in a Kansas City paper of Oct. 27, 1915, reports blue-stem grass (*Andropogon furcatus*) growing to a height of $9\frac{1}{2}$ feet in Chase County, Kansas.

Pp. 276, 284. Both Hempstead Brook and East Meadow Brook within the prairie area are dry most of the time now, a considerable change having taken place in that respect within the writer's recollection, perhaps on account of the lowering of the ground-water about their sources by pumping from deep wells to supply the rapidly growing villages.